RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #9

Draft 4 of TIS-B MOPS Material for Sections 2.2.17 And 2.4.17

Action Item 8-9

Presented by Vincent Orlando

SUMMARY
This working paper presents the 4th draft of TIS-B MOPS material intended for insertion as paragraphs 2.2.17 and 2.4.17. The text that is changed is identified in red and with a change bar in the right hand margin.
Specific changes relative to the last version are: (1) the addition of NIC Supplement, NAC and SIL fields to the Operational Status message, (2) changing the material on management messages to indicate reserved for future use, and (3) the addition of details for Ground Track Status, Ground Track Angle and Ground Speed in the Coarse Position format based on comments received from industry.

Introduction

At the eighth meeting, the third draft of TIS-B MOPS material for insertion into DO-260A at subparagraph 2.2.17 was reviewed. This working paper represents the continuation of the flushing out of materials and text for the requirements for TIS-B in section 2.2.17 and 2.4.17.

2.2.17   **Traffic Information Service Broadcast**

2.2.17.1   **Introduction**

TBD

2.2.17.2   **TIS-B Format Structure**

DF:5=18	CF:3	AA:24	ME:56	PI:24

Figure 2.2.17.2: TIS-B Format Definition

Table 2.2.17.2: "CF" Field Code Definitions in DF=18 ADS-B and TIS-B Messages.

CF Value	ICAO/Mode A Flag (IMF)	Meaning
0	N/A	ADS-B message from a non-transponder device, AA field holds 24-bit ICAO aircraft address
1	N/A	Reserved for ADS-B message in which the AA field holds anonymous address or ground vehicle address or fixed obstruction address
2	0	Fine TIS-B message, AA field contains the 24-bit ICAO aircraft address
2	1	Fine TIS-B message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number
3	0	Coarse TIS-B airborne position and velocity message, AA field contains the 24-bit ICAO aircraft address
3	1	Coarse TIS-B airborne position and velocity message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number.
4	N/A	Reserved for TIS-B management message AA field holds TIS-B service volume ID + other information (e.g., MSB of reference position for the service volume)
5 – 7	N/A	Reserved for other uses (e.g., for FIS-B messages)

2.2.17.2.1   **"DF" Downlink Format**

This field shall be set to DF=18 to indicate that this transmission is not from a Mode S transponder. See subparagraph 2.2.3.2.1.1.4.

2.2.17.2.2   **"CF" control Field**

This field shall be set to 2, 3 or 4 depending upon the TIS-B message as specified in Table 2.2.17.2.

2.2.17.2.3   **"AA" Address Announced**

As specified in Table 2.2.17.2, the AA field shall contain either:

(1) the ICAO 24-bit aircraft address as specified in subparagraph 2.2.3.2.1.1.1, or

(2) the 12-bit Mode A code followed by a 12-bit track number.,

2.2.17.2.4   **"ME" Message Extended Squitter**

This field shall be set as specified in subparagraph 2.2.3.2.1.1.5.

2.2.17.2.5   **"PI" Parity/Identify**

This field shall be set as specified in subparagraph 2.2.3.2.1.1.6.

2.2.17.3   **TIS-B Messages**

2.2.17.3.1   **TIS-B Fine Airborne Position Message**

TIS-B Fine Airborne Position Message Format							
MSG BIT #	33 --- 37	38 --------- 39	40	41 ----- 52	53	54	55 -------- 71	72 -------- 88
"ME" BIT #	1 ----- 5	6 ----------- 7	8	9 ----- 20	21	22	23 -------- 39	40 -------- 56
Field Name	TYPE [5]	Surveillance Status [2]	IMF [1]	Pressure Altitude [12]	Reserved [1]	CPR Format (F) [1]	CPR Encoded Latitude [17]	CPR Encoded Longitude [17]
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the specific field.*

Figure 2.2.17.3.1: TIS-B Fine Airborne Position Message Format

2.2.17.3.1.1   **Relationship to ADS-B Format**

The following fields shall be coded as specified for the ADS-B Airborne Position Message defined in subparagraph 2.2.3.2.3:

Type, Surveillance Status, Altitude, CPR Format, Encoded Latitude and Encoded

Longitude.

2.2.17.3.1.2   ICAO/Mode A Flag (IMF)

This one-bit field (ME bit 8) shall indicate the type of identity associated with the aircraft data reported in the TIS-B message. IMF equal to ZERO (0) shall indicate that the TIS-B data is identified by an ICAO 24-bit address. IMF equal to ONE (1) shall indicate that the TIS-B data is identified by a "Mode A" code. A "Mode A" code of all zeroes shall indicate a primary radar target.

> *Note*:   *The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table 2.2.17.2.*

2.2.17.3.2   TIS-B Fine Surface Position Message

<table>
<tr><td colspan="9" align="center">TIS-B Fine Surface Position Message Format</td></tr>
<tr><td>MSG BIT #</td><td>33 -- 37</td><td>38 ------- 44</td><td>45</td><td>46 ----- 52</td><td>53</td><td>54</td><td>55 ------- 71</td><td>72 -------- 88</td></tr>
<tr><td>"ME" BIT #</td><td>1 ----- 5</td><td>6 --------- 12</td><td>13</td><td>14 ----- 20</td><td>21</td><td>22</td><td>23 ------- 39</td><td>40 -------- 56</td></tr>
<tr><td>Field Name</td><td>TYPE [5]</td><td>Movement [7]</td><td>Ground Track Status [1]</td><td>Ground Track [7]</td><td>IMF [1]</td><td>CPR Format (F) [1]</td><td>CPR Encoded Latitude [17]</td><td>CPR Encoded Longitude [17]</td></tr>
<tr><td></td><td>MSB

LSB</td><td>MSB

LSB</td><td></td><td>MSB

LSB</td><td></td><td></td><td>MSB

LSB</td><td>MSB

LSB</td></tr>
</table>

> *Note:*   *"[#]" provided in the Field Name column indicates the number of bits in the specific field.*

<u>**Figure 2.2.17.3.2:**</u> **TIS-B Fine Surface Position Message Format**

2.2.17.3.2.1   Relationship to ADS-B Format

The following fields shall be coded as specified for the ADS-B Surface Position Message defined in subparagraph 2.2.3.2.4:

Type, Movement, Ground Track Status, CPR Format, Encoded Latitude and Encoded Longitude.

2.2.17.3.2.2   ICAO/Mode A Flag (IMF)

This one-bit field (bit 21) shall be set as specified in subparagraph 2.2.17.3.1.2.

2.2.17.3.3 TIS-B Identification and Category Message

TIS-B Identification and Category Message Format										
MSG BIT #	33--37	38 --------- 40	41 -46	47-52	53 -58	59 -64	65 -70	71 -76	77 -82	83 -88
"ME" BIT #	1 --- 5	6 ------------- 8	9 -- 14	15 -20	21--26	27- 32	33 -38	39 -44	45 -50	51 -56
FIELD NAME	TYPE [5]	ADS-B EMITTER CATEGORY [3]	Ident Char. #1 [6]	Ident Char. #2 [6]	Ident Char. #3 [6]	Ident Char. #4 [6]	Ident Char. #5 [6]	Ident Char. #6 [6]	Ident Char. #7 [6]	Ident Char. #8 [6]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the specific field.*

Figure 2.2.17.3.3: TIS-B Identification and Category Message Format

2.2.17.3.3.1 Relationship to ADS-B Format

All of the message fields shall be coded as specified for the ADS-B Identification and Type Message defined in subparagraph 2.2.3.2.5.

2.2.17.3.3.2 Application

This message shall only be used for aircraft identified with an ICAO 24-bit address.

2.2.17.3.4 TIS-B Airborne Velocity Message

TIS-B VELOCITY INFORMATION MESSAGE - SUBTYPES "1" and "2"																
MSG BIT #	33-37	38 ------ 40	41	42 ------- 45	46	47 --- 56	57	58 --- 67	68	69	70 -- 78	79	80 -- 83	84 -- 85	86 ----- 88
"ME" BIT #	1 --- 5	6 --------- 8	9	10 ------- 13	14	15 --- 24	25	26 --- 35	36	37	38 -- 46	47	48 -- 51	52 -- 53	54 ----- 56
FIELD NAME	TYPE [5]	SUBTYPE [3]	IMF [1]	Reserved [4]	E/W Direction Bit [1]	E/W Velocity [10]	N/S Direction Bit [1]	N/S Velocity [10]	Reserved [1]	Vert. Rate Sign [1]	Vert. Rate [9]	NIC [1]	NAC [4]	SIL [2]	Reserved [3]
	MSB LSB	MSB LSB		MSB LSB		MSB LSB		MSB LSB			MSB LSB		MSB LSB	MSB LSB	MSB LSB

Note: *"[#]" provided in the Field Name column indicates the number of bits in the specific field.*

Figure 2.2.17.3.4: TIS-B Airborne Velocity Information Message

2.2.17.3.4.1 Relationship to ADS-B Format

The following fields shall be coded as specified for the ADS-B Airborne Velocity

Message with Subtype equal to 1, as specified in subparagraph 2.2.3.2.6.1, or Subtype equal 2, as specified in subparagraph 2.2.3.2.6.2:

Type, Subtype, E/W Direction Bit, E/W Velocity, N/S Direction Bit, N/S Velocity, Vertical Rate Sign and Vertical Rate.

2.2.17.3.4.2 ICAO/Mode A Flag (IMF)

This one-bit field (bit 9) shall be set as specified in subparagraph 2.2.17.3.1.2.

2.2.17.3.4.3 Navigation Integrity Category (NIC) Supplement

This one-bit field (ME bit 47) shall be used together with the message type code to define the NIC value for the airborne and surface position messages.

Coding of the NIC Supplement field shall be as specified for the Operational Status Message in Table *__TBD__*.

2.2.17.3.4.4 Navigation Accuracy Coding (NAC)

This four-bit field (ME bits 48-51) shall define the NAC value for the airborne and surface position messages.

Coding of the NAC field shall be as specified for the Operational Status Message in Table *__TBD__*.

2.2.17.3.4.5 Surveillance Integrity Level (SIL)

This two-bit field (ME bits 52-53) shall define the SIL value for the airborne and surface position messages.

Coding of the SIL field shall be as specified for the Operational Status Message in Table *__TBD__*.

2.2.17.3.5 **TIS-B Coarse Position Message**

TIS-B Coarse Position Message Format										
MSG BIT #	33	34 ------- 35	36 -----39	40 -- 51	52	53 --- 57	58 -- 63	64	65 ------ 76	77 ----- 88
"ME" BIT #	1	2 -------- 3	4 ------- 7	8 ---19	20	21 --- 25	26 -- 31	32	33 ------ 44	45 ------ 56
Field Name	IMF [1]	Surveillance Status [2]	Service Volume ID (SVID) [4]	Pressure Altitude [12]	Ground Track Status [1]	Ground Track Angle [5]	Ground Speed [6]	CPR Format (F) [1]	CPR Encoded Latitude [12]	CPR Encoded Longitude [12]
		MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB		MSB LSB	MSB LSB

Note: "[#]" provided in the Field Name column indicates the number of bits in the specific field.

Figure 2.2.17.3.5: TIS-B Coarse Position Message Format

2.2.17.3.5.1 **ICAO/Mode A Flag (IMF)**

This one-bit field (bit 1) shall be set as specified in subparagraph 2.2.17.3.1.2.

2.2.17.3.5.2 **Service Volume ID (SVID)**

The 4-bit SVID field shall identify the TIS-B site that delivered the surveillance data.

Note: *In the case where TIS-B messages are being received from more than one TIS-B ground stations, the SVID can be used to select coarse messages from a single source. This will prevent the TIS-B track from wandering due to the different error biases associated with different sources*

2.2.17.3.5.3 **Pressure Altitude**

This field shall be coded as specified in subparagraph 2.2.3.2.3.4.1.

2.2.17.3.5.4 **Ground Track Status**

This one bit field (ME bit 20) shall define the validity of the ground track value. Coding for this field shall be as follows: 0=not valid and 1= valid.

2.2.17.3.5.5 **Ground Track Angle**

This 5-bit (ME bits 21-25) field shall define the direction (in degrees clockwise from true north) of aircraft motion. The ground track shall be encoded as an unsigned angular weighted binary numeral, with an MSB of 180 degrees and an LSB of 360/32 degrees,

with ZERO (0) indicating true north. The data in the field shall be rounded to the nearest multiple of 360/32 degrees.

2.2.17.3.5.6   Ground Speed

This 6-bit (ME bits 26-31) field shall define the aircraft speed over the ground. Coding of this field shall be as shown in Table 2.2.17.3.5.6.

Table 2.2.17.3.5.6: Ground Speed Encoding

Coding (binary)	Coding (decimal)	Meaning (Ground Speed in knots)
00 0000	0	No Ground Speed information available
00 0001	1	Ground Speed < 16 knots
00 0010	2	16 knots ≤ GS < 48 knots
00 0011	3	48 knots ≤ GS < 80 knots
***	***	***
11 1110	62	1936 knots ≤ GS < 1968 knots
11 1111	63	GS ≥ 1968 knots

Notes:

1.   The encoding shown in the table represents Positive Magnitude data only.

2.   *Raw data used to establish the Ground Speed Subfield will normally have more resolution (i.e., more bits) than that required by the Ground Speed Subfield. When converting such data to the Ground Speed Subfield, the accuracy of the data shall be maintained such that it is not worse than +/- ½ LSB where the LSB is that of the Ground Speed subfield.*

2.2.17.3.5.7   Encoded Latitude

This field shall be encoded as specified in subparagraph 2.2.3.2.3.7, except that the 12-bit CPR coding specified in **_TBD_** shall be used.

2.2.17.3.5.8   Encoded Longitude

This field shall be encoded as specified in subparagraph 2.2.3.2.3.8, except that the 12-bit CPR coding specified in **_TBD_** shall be used.

RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #12

**Draft of MOPS Material for TIS-B Message Processing and Reporting,
Sections 2.2.17.4 to the end of 2.2.17**

Presented by William Harman

SUMMARY

The second draft of TIS-B reporting material was reviewed at the previous meeting. In the discussion, several changes were suggested. These have been incorporated in the draft. This paper presents the revised draft of this TIS-B material.

This paper addresses action item # 11-05.

All text changed from the previous Working Paper (1090-WP-11-12) are presented in RED.

**Draft of MOPS Material for TIS-B Message Processing and Reporting,
Sections 2.2.17.4 to the end of 2.2.17**

Beginning in our January 2002 meeting, our Working Group decided on an approach for TIS-B. The received TIS-B information will be reported directly, with a minimum of processing. One element for which processing is required is latitude-longitude decoding, which requires global decoding by combining even and odd receptions.

This paper presents the third draft of the requirements for TIS-B reporting, based on comments and decisions at the meeting in May. The following specific changes were made.

(1) Addition of a test for invalid addresses, specifically all zeros and all ones.

(2) Addition of a note saying that a track reasonableness test may be applied.

(3) Addition of a requirement to generate a full state vector report when either a position or a velocity message is received.

(4) Simplification of the track-state figure as discussed at the meeting.

A few wording changes were also made to improve clarity, and section reference numbers were corrected in several places.

===============

2.2.17.4 TIS-B Message Processing and Report Generation

The information received in TIS-B messages is reported directly to applications, with one exception. The exception is latitude-longitude position information, which is CPR-encoded when it is received, and must be decoded before reporting. In order to accomplish CPR decoding, it is necessary to track received messages, so that even-format and odd-format messages can be combined to determine the latitude and longitude of the target.

In the most common case, a particular target will result in TIS-B message receptions or ADS-B message receptions, but not both. It is possible, however, for both types of messages to be received for a single target. Therefore TIS-B messages are compared with tracks of previous TIS-B receptions and tracks of ADS-B receptions. The tracking structure within ADS-B can either use separate tracking of TIS-B receptions and ADS-B receptions or combined tracking of the two types of receptions.

2.2.17.4.1 TIS-B Message-to-Track Correlation

Tracking makes it possible to associate a received message with information previously received about that same target, in the presence of many other intervening messages about other targets. As TIS-B position messages are received, they are compared with existing tracks. If a received TIS-B message correlates with an existing track, the message is decoded (2.2.17.4.2), the track is updated (2.2.17.4.3), and a report is generated (2.2.17.6). If the new message does not correlate, it is used in new-track initiation (2.2.17.4.4).

2.2.17.4.1.1 TIS-B Messages Having a 24-Bit Address

For a target that has a 24-bit address, that address is used for correlating new receptions with information in the track file. Correlation is successful if the address matches exactly. If the 24-bit address in a received message is either all zeros or all ones, it is considered to be illegal, and the message shall be discarded. Otherwise, when a TIS-B position message having a 24-bit address is received, and an existing TIS-B track has the same address, the message shall be correlated with the track. When a TIS-B message having a 24-bit address is received, and an existing ADS-B track has the same address, the message shall be correlated with the track.

2.2.17.4.1.2 TIS-B Messages Having Mode A Code and Track Number

For a target not identified by a 24-bit address, but instead having a Mode A code and a TIS-B track number, then these are used to correlate with information in the track file. Correlation is successful if the Mode A code and the track number both match exactly. When a TIS-B message having a Mode A code and TIS-B track number is received, and an existing TIS-B track has the same Mode A code and ADS-B track number, the message shall be correlated with the track.

2.2.17.4.2 TIS-B Position Message Decoding

When a received TIS-B position message correlates to an existing track, the message and the track are used together to decode the latitude and longitude of the target. If the track is "Complete", meaning that a global decode has been accomplished, then the new latitude-longitude information shall be decoded using local decoding, as specified in A.1.7.4 in Appendix A, taking the previous position of the target as the reference.

If the track is Incomplete, meaning that a global decode has not yet been accomplished prior to this reception, then a global decode may be computed depending on the contents of the track. If the information in the track together with the new position message consist of at least one even format message and at least one odd format message received within 10 seconds, then a global decode shall be computed as specified in A.1.7.7 of Appendix A. Otherwise the received encoded position, the even/odd format, and the time of applicability, shall be saved in the track file for later use.

For ADS-B tracks, as illustrated in Figure 2-16b, a track is Complete if it is in the Track State or is in the Acquisition State. Otherwise the track is Incomplete.

Note. When decoding positions, a reasonableness test may be applied.

2.2.17.4.3 TIS-B Track Update

When a position message is correlated to a TIS-B track that is Complete, then a new position is computed as specified in 2.2.17.4.2 and the tracked position shall be updated with the new position and time of applicability. The previous position and time need not be saved. Figure 2.2.17.4.3 illustrates the transition from Incomplete track to Complete track and later track drop.

When a position message is correlated with a TIS-B track that is Incomplete, the new information may make it possible for a global decode, as specified in 2.2.17.4.2. If a global decode is accomplished, the track shall be promoted to Complete, and the latitude, longitude, and time of applicability shall be saved in the track. The previous position and time information need not be saved. If a global decode is not accomplished, the even and odd encoded positions shall be saved for future decodes.

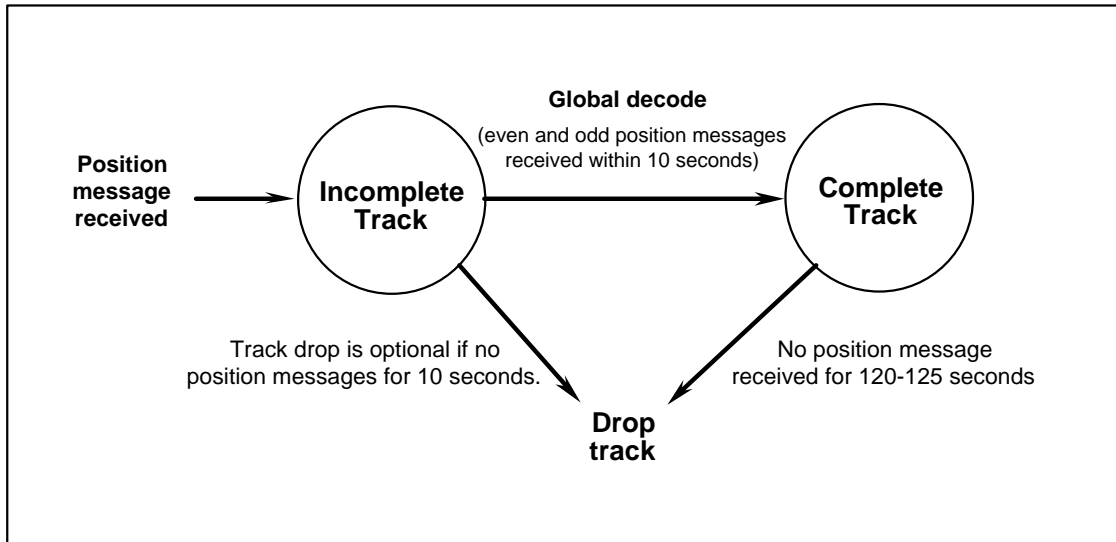*Note. It is not necessary to save any encoded positions longer than 10 seconds.*

Figure 2.2.17.4.3. TIS-B Tracks

2.2.17.4.4 TIS-B Track Initiation

A TIS-B track begins with the reception of one position message. A new Incomplete track shall be created, and the encoded position, even/odd format bit, and time of applicability shall be saved.

2.2.17.4.5 TIS-B Track Drop

A TIS-B track that is Complete shall not be dropped within 120 seconds after any TIS-B position message reception. If 125 seconds elapses without any TIS-B message reception, the track shall be dropped.

Note. As specified in 2.2.17.4.3, for an Incomplete TIS-B track, it is not necessary to save any information more than 10 second after reception. Therefore the track can be dropped after 10 seconds.

2.2.17.4.6 TIS-B Report Generation

As TIS-B messages are received, the information is reported to applications. All received information elements, other than position, shall be reported directly. The reporting format is not specified in detail, except that the information content reported shall be the same as the information content received. The report shall be issued within 0.5 seconds of the message reception.

When a TIS-B position message is received, it is compared with tracks to determine whether it can be decoded into target position, as specified in 2.2.17.4.2. If the message is decoded into target position, a state vector report shall be generated, within 0.5 seconds of the message reception. The report shall contain the latitude, longitude, altitude, estimated velocity, address, time of applicability, and all other information in the received message. The estimated velocity shall include north-south velocity, east-west velocity, and altitude rate.

These rates shall be estimated based on the received position information and the track history of this target.

When a TIS-B velocity message is received, if it is correlated to a complete track, then a state vector report shall be generated, within 0.5 seconds of the message reception. The report shall contain the received velocity information, estimated position, address, time of applicability, and all other information in the received message. The estimated position shall include latitude, longitude, and altitude. These values shall be estimated based on the received velocity information and the track history of this target.

Note. In the absence of TIS-B message receptions, it is possible for reports to be generated, but this is not required. Such additional reports might be useful as a means of counteracting possible flaws in an on-board data bus between ADS-B and an application.

===========